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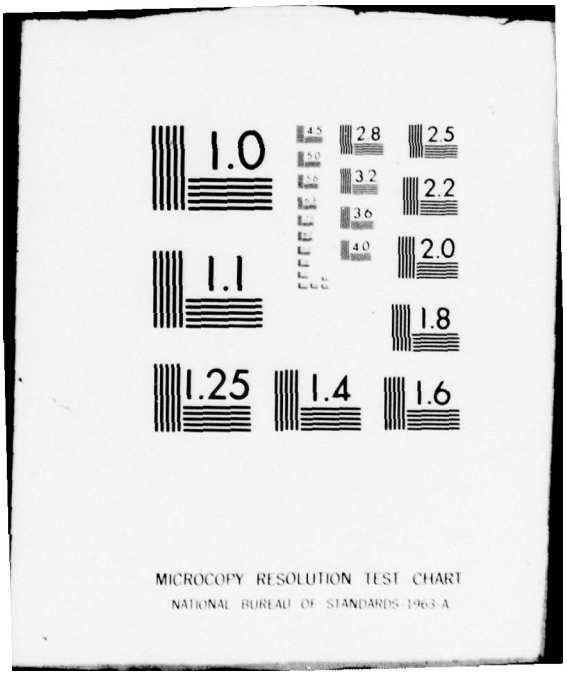
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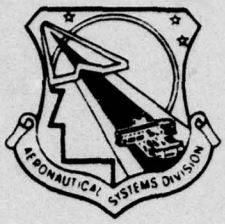

DESIGN TO COST IMPLEMENTATION GUIDANCE

JANUARY 1978

DIRECTORATE OF COST ANALYSIS
COMPTROLLER
AERONAUTICAL SYSTEMS DIVISION
WRIGHT-PATTERSON AFB, OHIO 45433

DESIGN TO COST (DTC) IMPLEMENTATION GUIDANCE

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JANUARY 1978

21 p.

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FOREWORD

The need to reduce the costs of acquiring and owning weapon systems requires that cost objectives be treated as co-equal with performance and schedule objectives. Making cost a primary management and design objective is implemented by the Design to Cost (DTC) concept. The purpose of this document is to provide guidance on how to implement the DTC concept. This guidance is a by-product of the efforts of the ASD/AFALD Life Cycle Cost/ Design to Cost Advisory Group. It includes DTC information and guidance most frequently sought by program personnel. The guidance supplements information in DODD 5000.28, AFR 800-11, AFSCP/AFLCP 800-19, and ASDR 800-17(TEST). We welcome any suggestions for improving this guide.

I have reviewed and approved this report.

CHARLES W. ADAMS
Director of Cost Analysis
Comptroller

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

This Chapter provides general policy and concept information in the form of Questions and Answers. The questions are those most often asked by program personnel when they become involved in implementing the DTC concept.

Q. What is Design-to-Cost?

A. A management concept which establishes rigorous cost goals for development and controls systems costs (acquisition, operating, and support) by practical tradeoffs between operational capability, performance, cost and schedule. Cost, as a key design parameter, is addressed on a continuing basis as an inherent part of the development and production process. (DODD 5000.28)

Q. How does Design-to-Cost relate to Life Cycle Cost?

A. Design-to-Cost is a management-by-objectives approach to reduce and control life cycle cost.

Q. What is a Design-to-Cost Goal? Threshold?

A. A highly visible cost number the program manager strives to obtain. This goal guides program activities in the same manner as schedule and performance objectives. Achievements measure the program cost performance. DTC thresholds have somewhat greater values than DTC goals. Thresholds, when broken, trigger program reassessment.

Q. What is Air Force Policy on the Use of Cost Goals?

A. Cost-related design goals "must be established and approved" for acquisition or modification programs involving design effort. This policy applies retroactively to on-going programs.

Q. What DTC goals and thresholds are required?

A. As a <u>minimum</u>, establish cost goals for:

(1) Average unit cost for production versions of the product (includes nonrecurring and recurring cost).

(2) Unit operating crew and maintenance manpower requirements.

(3) Operational reliability and maintainability parameters.

(4) Selected design controllable factors which significantly affect the life cycle cost of the product.

Q. When must a DTC goal and threshold goal be established?

A. By Milestone I (Demonstration and Validation) and updated by Milestone II (Full Scale Engineering Development).

Q. Who is the approval authority for cost goals?

A. The highest management level that will exercise regular review authority over the program. For DSARC programs the approval authority is the Secretary of Defense. For non-DSARC programs, the approval authority at ASD is the deputate level unless a higher level is designated.

Q. Can a DTC goal be waivered? If so, by whom?

A. Waivers are authorized only by the approval authority. Waivers may be appropriate for:

(1) Acquisition programs where the end product serves research and development purposes only and ownership costs are insignificant.

(2) System or subsystem programs in production and no design or development remains.

Q. Can a DTC goal be changed?

A. Yes, by the approval authority only. Changes are appropriate when goals are no longer attainable and thresholds will be exceeded. Changes in program direction, such as funding profiles, delivery schedules, design requirements and other factors beyond program management control normally impact the goal, therefore, a goal adjustment is appropriate.

Q. How are Design-to-Cost goals established?

A. Normally by an LCC analysis or experience from similar operational products. The goal improves upon that experience. Approaches include:

(1) Cost history of the system or subsystem to be replaced.

(2) Cost of a similar system or subsystem adjusted for performance objectives.

(3) Cost of a similar system or subsystem adjusted to allow for use of technology to reduce costs.

(4) "Ball-Park" estimate of acceptable or affordable cost to which performance must conform.

(5) Industry survey.

(6) Engineering grass-roots estimate.

(7) RCA PRICE or similar cost estimating model.

Q. How does a program DTC goal relate to a contractual DTC target?

A. A program DTC goal is a "contract" between the program manager and a higher designated authority. A contractual DTC target is that portion of the program DTC goal controlled by the contractor. For example, the contractual DTC target excludes costs for Government furnished equipment and allowance for change orders.

CHAPTER 2

DTC PROGRAM CONSIDERATIONS

The Program Manager documents DTC/LCC program considerations in the Program Management Plan (PMP) and the Procurement Plan (PP). Programs with extensive DTC/LCC plans may use a PMP annex. DTC planning considers the following:

(1) Goal Definitions

(2) Trade-Study Guidelines

(3) Goal Adjustment Criteria

(4) Tracking Requirements

(5) Program Reviews

(6) Contract Requirements

GOAL DEFINITIONS

DTC goal definitions should use standard cost terms. Cost terms are defined by effort, services, or items of hardware or software. They are further defined by identifying functional cost elements and appropriations. Definitions of standard cost terms are included in the following sources:

(1) MIL-STD-881-A, Work Breakdown Structure for Defense Materiel Items. This Standard defines WBS elements.

(2) AFLCP/AFSCP 800-15, Contractor Cost Data Reporting (CCDR) System Pamphlet. This pamphlet defines functional cost elements as they apply to Work Breakdown Structure (WBS) elements.

(3) Cost Analysis Improvement Group (CAIG) Operating and Support (O&S) Cost Guides. These guides define weapon system O&S cost elements.

(4) AFM 172-1, USAF Budget Manual Policies and Procedures. This manual provides appropriation related definitions and funding distinctions.

There are seven standard cost terms. Figure 1 displays the terms by identifying the cost category and WBS element descriptions which are needed to complete each definition. This figure should be read from the center out by selecting the cost term to be defined. Once the term is located, the area enclosed by the box connected to the term identifies the three basic components which define each definition in terms of (1) cost category (on the left side); (2) work breakdown structure elements (on the top when they apply); and (3) primary appropriations (on the right side). The seven cost terms are described as follows:

a. Development Cost. Development cost includes:

(1) Work Breakdown Structure (WBS) elements of Major System Equipment, System/Project Management, System Test and Evaluation (except Operational Test and Evaluation funded from Military Personnel or Operation and Maintenance appropriation), Training, Peculiar Support Equipment, Data, Operational/Site Activation and Industrial Facilities.

(2) RDT&E funded costs (i.e., conceptual, validation, full scale development phases from the point the program/system is designated by title as a Program Element or major project in a Project Element); and

(3) All costs, both contract and in-house, of the Research and Development cost category, including the cost of specialized equipment, instrumentation, test and facilities required to support RDT&E contractor and/or Government installation.

b. Flyaway Cost. Flyaway is used as a generic term related to the creation of a usable end item of hardware/software. Flyaway cost includes:

(1) WBS elements of Major System Equipment (such as basic structure, propulsion, electronics, including Government Furnished Equipment, etc.) System/Project Management, and System Test and Evaluation (if any of this effort is funded by Procurement).

(2) Procurement funded costs (i.e., Line Item Procurement Program); and

(3) All costs, both contract and in-house, of the Production Nonrecurring and Recurring cost categories, including allowances of engineering changes, warranties, and first destination transportation, unless the latter is a separate budget line item.

c. Weapon System Cost. Weapon System Cost includes:

(1) The same WBS elements as in Flyaway Cost (i.e., Major System Equipment, System/Project Management, System Test and Evaluation (if any of this effort is funded by Procurement), plus WBS elements:Training, Peculiar Support Equipment, Data, Operational/Site Activation, and Industrial Facilities (unless funded as a separate budget line item or by RDT&E).

(2) Procurement funded costs; and

(3) All costs, both contract and in-house, of the Production Nonrecurring and Recurring cost categories, including allowances for engineering changes, warranties, and first destination transportation, unless the latter is a separate budget line item.

d. Procurement Cost. Procurement cost includes:

(1) The same WBS elements as in Weapon System Cost (i.e., Major System Equipment, System/Project Management, System Test and Evaluation (if any of this effort is funded by Procurement), Training, Peculiar Support Equipment, Data, Operational/Site Activation, and Industrial Facilities (unless funded as a separate budget line item or by RDT&E, plus the WBS element: Initial Spares and Initial Repair Parts;

(2) Procurement funded costs; and

(3) All costs, both contract and in-house, of the Production Nonrecurring and Recurring cost categories, including allowance for engineering changes, warranties, and first destination transportation, unless the latter is a separate budget line item.

e. Program Acquisition Cost. Program Acquisition Cost consists of Development Costs, Procurement Costs, and any construction costs which are in direct support of the system or project. Program Cost and Program Acquisition Cost are synonymous terms. Program Acquisition Cost includes:

(1) The WBS elements of Major System Equipment, System/Project Management, System Test and Evaluation (except Operational Test and Evaluation funded from Military Personnel or Operation and Maintenance), Training, Peculiar Support Equipment, Data, Operational/Site Activation, Industrial Facilities (unless funded by Procurement as a separate budget line item), and Initial Spares and Initial Repair Parts;

(2) RDT&E, Procurement and MILCON funded costs; and

(3) All costs, both contract and in-house, of the Research and Development and Production (Nonrecurring and Recurring) cost categories, including allowances for engineering changes, warranties, and first destination transportation, except when the latter is a separate budget line item.

f. Ownership. Ownership cost encompasses the cost elements within the Operating and Support (O&S) cost category exclusively. O&S costs include those costs associated with operating, modifying, maintaining, supplying, and supporting a weapon/support system in the DOD inventory.

(1) Included are costs for skill training, personnel movement, replenishment spares and repair parts.

(2) Operation and Maintenance (O&M), Military Personnel, Procurement, Military Construction, other appropriations and funds (stock fund) are used to operate and support DOD weapon/support systems.

g. Life Cycle Cost. Life Cycle Cost includes all WBS elements; all related appropriations; and encompasses the costs, both contract and in-house, for all cost categories. It is the total cost to the Government for a system over its full life, and includes the cost of development, procurement, operating, support, and where applicable, disposal.

TRADE-STUDY GUIDELINES

Trade studies can lead to life cycle cost reductions by identifying design simplification, producibility changes, and maintainability, reliability and supportability improvements. Generally speaking, trade studies are done on the major hardware/software cost elements and performance parameters having the most potential cost reduction payoff. The Government may require the contractor(s) to identify trade study candidates and to perform selected trade studies. To ensure a realistic approach to trade studies, it is necessary to follow specified groundrules. As such, trade studies should include the following:

OBJECTIVES: State objective for the study.

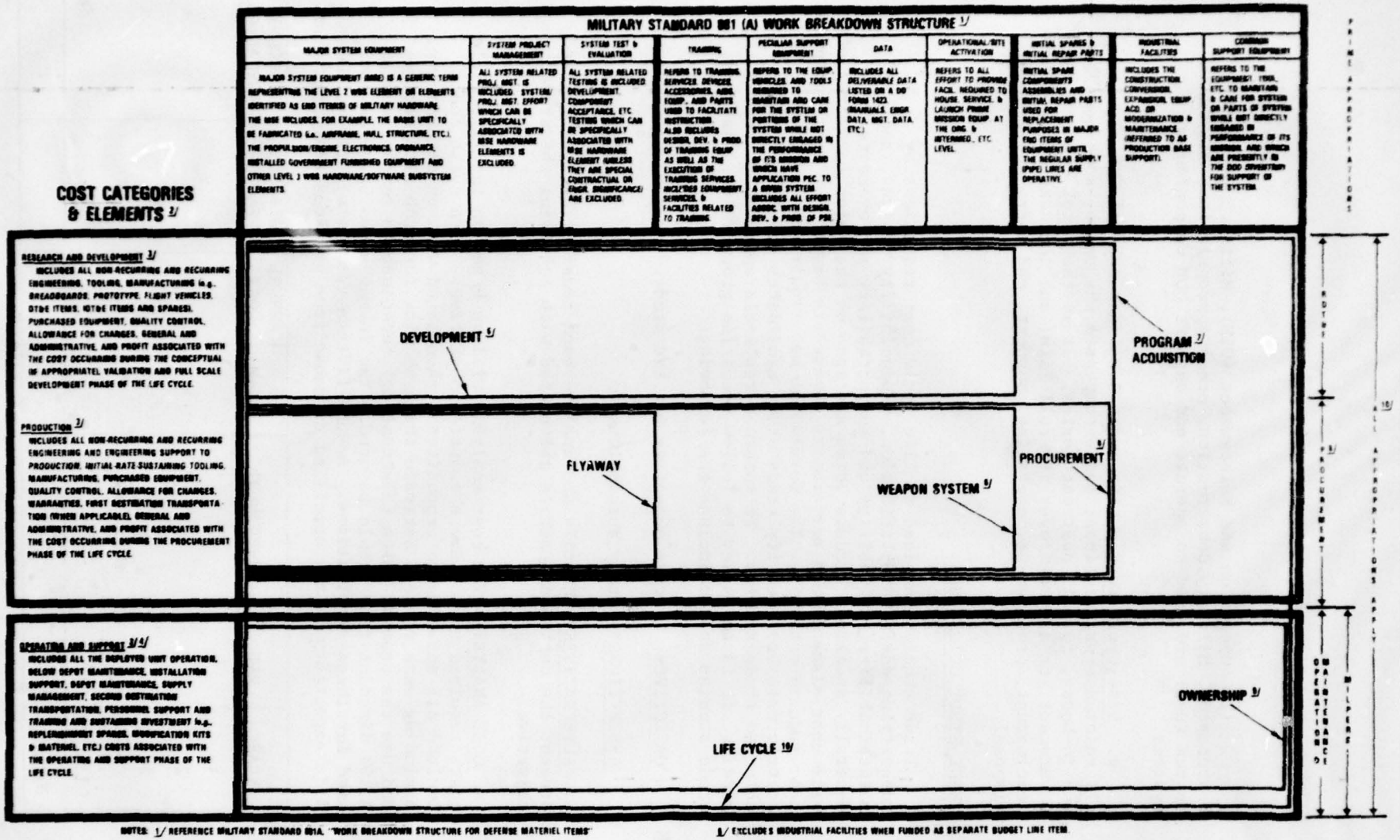
ASSUMPTIONS: Study assumptions.

ALTERNATIVES: Identify and analyze each feasible alternative and present the cost and benefits associated with achieving the stated objective.

COST ANALYSIS: The cost analysis will be based on the life cycle costs required to achieve the stated objective. Life cycle costs include all anticipated expenditures associated with an alternative, excluding sunk costs. Estimate the cash flow for each alternative and use the present value (discounting) technique to compare costs. A 10% discount rate should be used. The format shown below may be used for these computations. Assume fifteen years when operational life expectancy is not specified or known from previous usage patterns.

YEAR	R&D	INVESTMENT	O&M	ANNUAL COST	DISCOUNT FACTOR	DISCOUNTED ANNUAL COST
1.						
2.						
3.						
.						
.						
15.						
TOTALS						

COST DEFINITION DISPLAY



NOTES: 1/ REFERENCE MILITARY STANDARD 881A, "WORK BREAKDOWN STRUCTURE FOR DEFENSE MATERIEL ITEMS"

2/ FUNCTIONAL COST AS USED IN CONTRACTOR COST DATA REPORTING AND COST INFORMATION REPORTS.

3/ INCLUDES BOTH CONTRACT AND IN-HOUSE COST ELEMENTS; APPROPRIATE COST ELEMENTS INCLUDE COST BY: LABOR, MATERIAL, OVERHEAD AND OTHER DIRECT CHARGES.

4/ THE WBS DOES NOT APPLY TO THE OPERATING AND SUPPORT COST CATEGORY.

5/ WHEN INDUSTRIAL FACILITIES ARE FUNDED BY RDT&E IT WILL BE INCLUDED AS APPROPRIATE.

6/ EXCLUDES INDUSTRIAL FACILITIES WHEN FUNDED AS SEPARATE BUDGET LINE ITEM.

7/ MILITARY CONSTRUCTION IS ALSO INCLUDED WHEN WEAPON SYSTEM RELATED.

8/ INCLUDES SHIPBUILDING AND CONVERSION, NAVY APPROPRIATION.

9/ OTHER APPROPRIATIONS (e.g., PROCUREMENT, ETC.) ARE INCLUDED AS APPROPRIATE.

10/ ALL APPROPRIATIONS (e.g., RDT&E, PROC., MILCON, MILPER, ETC.) APPLY AS APPROPRIATE.

FIGURE I

OUTPUT ANALYSIS: Provide estimates for all benefit outputs or effectiveness expected. Where feasible, these will be compared to related programs or systems.

RANKING OF ALTERNATIVES: Cost reduction investment proposals must show the ratio of investment to savings and the rate of return on investment.

RISK/UNCERTAINTY ANALYSIS: Include a risk and uncertainty analysis of the assumptions and cost estimates. Risk assessments will be made to determine the expectation or probability that the study results will be realized by following a specific course of action with constraints of time, cost and technical performance. Uncertainty analysis will address unexpected program changes and unforeseen problems.

CONSTRAINTS: Identify any limitations associated with the alternatives.

SENSITIVITY ANALYSIS: Test the sensitivity of any factor, especially performance requirements, which may significantly impact the analysis results.

GOAL ADJUSTMENT CRITERIA

Criteria should be established for adjusting DTC goals when added cost in one area e.g., acquisition may result in significant savings in another area e.g., ownership. Criteria may be established in the form of ratios or percentages. On a recent program, criteria was established allowing for a maximum upward adjustment in acquisition cost of 50% of the expected constant dollar discounted savings over the first ten years of in-service usage. This criteria also stated: "As a general management rule, if the savings is realized in reduced fuel costs, the maximum adjustment (50%) will be applied. If the area of savings involves reduced hardware (spare and support equipment) the maximum adjustment will be 33% of the expected savings. If the area of savings is manpower costs, the maximum adjustment will be 20% of the expected savings, lesser adjustment percentages will be used to reflect the degree of uncertainty surrounding the potential savings and the effect of sensitivity analysis on relevant parameters. However, any development or procurement goal adjustment shall be limited by the legal funding and budget constraints on those monies."

TRACKING REQUIREMENTS

Tracking is used to assess the progress of the DTC effort. Normally, DTC management reviews are required to evaluate specific design progress. Reviews are related to the maturity of the concept or design and are keyed to selected milestones such as:

(1) drawings completed

(2) hardware fabricated

(3) hardware tested

(4) vendor quotes received

(5) contracts negotiated

(6) design reviews completed

(7) reliability and maintainability tests completed

The confidence placed in the cost estimates should increase as the completion percentage for each milestone increases, and as subsequent milestones are reached.

Contractor DTC tracking uses the work breakdown structure and related work unit codes to track DTC targets. Targets are sub-allocated to individual design groups. These estimates are also shown by functional cost element. Reviews include analysis of variances between the current estimates and prior estimates or the DTC goal or contractual target. The review should also include corrective actions proposed or implemented for over target variances or advantages taken for under target conditions. An example of a formal data item is listed in AFSCP/AFLCP 800-19 for tracking DTC status.

A formal DTC Demonstration may be appropriate on large programs and should be specifically called for in the contract. The DTC Demonstration requires the contractor to demonstrate to the Government the actions he has taken and is taking to meet his DTC commitments. These demonstrations normally correspond to DSARC milestones.

PROGRAM REVIEWS

DTC status is reported at program reviews as follows:

(1) "DTC Estimate Track" is presented as a special subject during the reviews.

(2) The "Program Managers' Assessment" chart contains an additional line entitled, "Design to Cost." The program manager will provide an assessment of progress toward achieving the goal(s).

CONTRACT REQUIREMENTS

DTC/LCC Program:

The Request for Proposal (RFP) should request the offeror to propose a DTC management approach compatible with the Statement of Work (SOW). All of the DTC/LCC requirements are documented in the SOW. The contractor documents how he will implement these requirements in a DTC/LCC program plan. The DTC approach should establish life cycle cost as a parameter to be considered equally with technical requirements and schedule throughout the design, development, production and deployment of the program. The offeror's approach should provide the following:

1. INTERNAL CONTROLS

a. Establishing goals and subgoals and suballocations of these goals at various management levels down to the engineering responsibile for a specific cost account.

b. Providing incentives to meet or better assigned subgoals.

c. Identifying those hardware/software items and program tasks which have a dominant effect on the total LCC.

d. Establishing and maintaining the logistics support cost "drivers" data file with supporting input parameter rationale. The data in this file must be consistent with the data contained in the Integrated Logistics Data File, the Failure Modes and Effects Analysis, Logistics Support Analysis, and Spares Provisioning process.

e. Incorporating DTC requirements in design subcontracts.

2. LCC TRADE STUDIES

a. Identifying and prioritizing potential LCC reductions.

b. Identifying new study candidate items.

c. Implementing the LCC trade study effort.

3. STATUS ASSESSMENT AND REPORTING

a. Determining and tracking the DTC status.

b. Reconciling the DTC estimates with the C/SCSC or other cost management and logistics data systems.

c. Identifying, documenting and tracking design decisions made to reduce the LCC.

d. Providing a high degree of Government and contractor visibility into LCC activities.

e. Providing timely support to Air Force program validation reviews.

4. INTEGRATION

a. Providing information and incentives to each organization level to consider LCC on an equal basis with technical requirements and schedule.

b. Providing a cross-reference between the Work Breakdown Structure and the Work Unit Code.

Incentives:

Incentives provide motivation for the contractor and are useful to draw attention to those areas where special effort is desired. Reference is directed to the "Life Cycle Cost Procurement Guide" for further guidance in this area.

CCP/ECP/VECP Analysis:

The contract should specifically state that all ECPs will require an analysis of how the proposed change affects the DTC goals and LCC of the program. This is normally accomplished by modifying the applicable DD Form 1423 and Data Item Descriptions.

Data:

The following Data Item Descriptions are available:

(1) DI-S-3569: SYSTEM COST EFFECTIVENESS PROGRAM PLAN/ DESIGN TO LIFE CYCLE COST REPORTS. This data item provides for periodic reporting of the contractor's projection of the Weapon System Cost, Other Support Cost, and Operating and Support Cost during the Development and Production Programs.

(2) UL-76-AQ: LOGISTIC SUPPORT COST (LSC) STATUS REPORT. This data item describes the LSC model which is used by the contractor as a decision and for investigating design tradeoffs. It provides for a periodic status report of the master data file and the model results.

CHAPTER 3

CONTRACTOR DTC PROGRAM ASSESSMENT

The role of the contractor in DTC is crucial because he is the one ultimately doing the "design" work. Making cost a primary design objective cannot be accomplished without a contractor's commitment. This Chapter outlines characteristics of a contractor's DTC program. Setting DTC targets and keeping score are useful. However, this costs money and makes no contribution unless astute management and key engineering talent are committed to bringing the system into production at or under the targets originally established for the program. A responsive DTC reporting system will provide the cost visibility to the engineering decision-makers so they can maintain control of the design's cost parameter. Sustained visibility on costs will almost always require further analysis and innovation from design, purchasing, and manufacturing engineering. Each high cost item will be studied in cost and technical depth to: (1) update obsolete items, (2) remove unnecessary features, (3) simplify high cost features, (4) improve operational readiness, reliability and maintainability. Manufacturing engineering working in concert with the design engineer, will provide the cost validation of manufactured and purchased components. Where their analysis reveals costs greater than target, they will provide manufacturing approaches and suggested design concepts to keep the production costs on target. Cost driver items will be analyzed for make or buy competition and subcontractor bids will be analyzed to determine cost impact of each requirement.

Criteria for assessing a Design to Cost effort are enumerated below:

1. A DTC manager is identified.

2. DTC management responsibilities are assigned to the appropriate organizations.

3. There is a functional organizational segment accomplishing the task of reducing system costs.

4. Priorities among "Design Requirements" are defined.

5. Design to cost actions include consideration of LCC impact.

6. A cost model(s) is developed to estimate production and ownership costs.

7. All cost estimates are assigned a level of maturity.

8. Cost estimating methods used by contractor are sound and based upon his prior experience for similar work.

9. Experience curve projections are supported by historical patterns of yield improvements.

10. Estimated production and ownership costs are distributed down to a level that represents specific targets for individual design groups.

11. Design groups are aware of their individual cost targets.

12. DTC status is provided to individual design groups on a timely basis.

13. Design to cost reports generated for contractor internal use are summarized for customer, program managers and corporate top management.

14. Program management reviews problems in meeting DTC targets on at least a monthly basis.

15. Management action regarding cost variances (estimated over targets) is evident and available to the designer.

16. Design groups review variance data for corrective action.

17. Trade off studies are being accomplished.

18. Trade off studies are available at design location.

19. Producibility estimating support is provided to the design groups.

20. Preliminary production cost estimating results are fed back to design groups in less than one week.

21. Production cost estimating results are fed back to design groups within fifteen working days.

22. Cost estimate traceability is available at design location.

23. Special management emphasis is given to high-cost items.

24. Cost drivers are identified for at least 80% of total estimated production and ownership costs.

25. Program managers are taking action on "cost-driver" specifications or design requirements.

26. Production and ownership cost estimates on all high-cost items (80% at least) can be validated by qualified Government cost analysts and engineers.

27. Reliability and maintainability data is compatible with LCC goals.

28. Design contracts incorporate Design to Cost targets.

29. Prime contractor exercises control criteria over subcontract DTC efforts.

30. Design to cost feedback from design subcontracts is available on a timely basis.

31. Design subcontracts include provisions for validation audit of high-cost items.

APPENDIX A

REFERENCES

DOD Directive 5000.28, Design to Cost

AFLC/AFSCP 800-19, Joint Design to Cost Guide

ASDR 800-17(TEST), Life Cycle Costing (LCC) and Design to Cost (DTC) Concept Implementation

AFLC/AFSCP 800-15, Contractor Cost Data Reporting

Cost Analysis Improvement Group Operating and Support Cost Guides

MIL-STD-881A, Work Breakdown Structure for Defense Materiel Items.

AFM 172-1, USAF Budget Manual Policies and Procedures

Life Cycle Cost Procurement Guide, ASD/ACCX

This document is the seventh of a series prepared to assist Air Force personnel to understand and apply life cycle costing techniques. Other documents in this series include:

Life Cycle Cost Plan Preparation Guidance, October 1975

Life Cycle Cost Analysis Guide, November 1975

Analysis of Available Life Cycle Cost Models and Their Applications, June 1976

Life Cycle Cost Procurement Guide, July 1976

Supplemental Life Cycle Costing Program Management Guidance, January 1977

Understanding and Evaluating Life Cycle Cost Models, March 1977

Copies of all of these documents are available from ASD/ACCX, Wright-Patterson AFB, Ohio 45433.